PANJAB UNIVERSITY, CHANDIGARH-160014(INDIA)
(Estd.under the Panjab University Act VII of 1947-enacted by the Govt. of India)

FACULTY OF ENGINEERING & TECHNOLOGY

SYLLABI

AND THE

REGULATIONS

FOR

M.Tech. in Microelectronics
2014-15

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FIRST SEMESTER (Any Five of the following and Research Seminar I)

MIC 6101  Semiconductor Device physics.
MIC 6102  Integrated Circuit Technology.
MIC 6103  MOS Integrated Circuit Modeling.
MIC 6104  Computer Aided Design Methodologies and Tools.
MIC 6105  Hardware Description Languages and VLSI Design.
MIC 6106  Material Science & Engineering.
MIC 6107  Embedded System Design.
MIC 6108  Research Seminar I.

SECOND SEMESTER (Any Five of the following and Research Seminar II)

MIC 6202  Measurement and Characterization Techniques.
MIC 6203  Architecture of VLSI System.
MIC 6204  Analog and Mixed Signal Device Design.
MIC 6205  Advanced Memory Technology and Design.
MIC 6206  MEMS and Microsystems.
MIC 6207  RF and High Speed Digital Design.
MIC 6208  Research Seminar II.

THIRD SEMESTER (Any Two of the Following and Thesis-1)

MIC 7101  Low Power Digital CMOS Design
MIC 7102  Microelectronic Packaging and Testing
MIC 7103  Nano Scale Devices and Systems
MIC 7104  Thesis-I

FOURTH SEMESTER

MIC 7201  Thesis-II
# EXAMINATION SCHEME

## FIRST SEMESTER

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Total Marks: 750  
Total Credits: 21

No marks are assigned to Research Seminar-I (MIC-6108) work. On successful presentation and completion of these courses the candidate will be awarded “S” grade i.e. satisfactory or else “X” grade i.e. unsatisfactory.

## SECOND SEMESTER

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Total Marks: 750  
Total Credits: 21

No marks are assigned to Research Seminar-I (MIC-6208) work. On successful presentation and completion of these courses the candidate will be awarded “S” grade i.e. satisfactory or else “X” grade i.e. unsatisfactory.
## THIRD SEMESTER

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Total Marks: 500
Total Credits: 18

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<td>Publication from Thesis in Scopus indexed Journal</td>
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<td>3.</td>
<td>B+</td>
<td>Publication from Thesis in Proceedings of Conference which is Scopus indexed</td>
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<td>4.</td>
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<td>Presented Paper in International Conference</td>
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## FOURTH SEMESTER

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<td>Thesis-II</td>
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Total Marks: 200
Total Credits: 15

**Thesis will be graded as follows:**

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<td>4.</td>
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<td>5.</td>
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<td>Presented Paper in National Conference</td>
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**GRAND TOTAL:**

**MARKS: 2200**

**CREDITS: 75**
SYLLABUS

COURSE CONTENTS FOR M.TECH (MICRO-ELECTRONICS)

1st SEMESTER

MIC 6101: SEMICONDUCTOR DEVICE PHYSICS

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.


Junction field effect transistor:-JFET concepts, device characteristics, nonideal effects, equivalent circuit and frequency limitation, Metal oxide Semiconductor field effect transistors:- Metal semiconductor ohmic contacts, MOS structure and operation, capacitance -voltage characteristics ,small signal equivalent circuits, nonideal effects. Hetrojunctions:-hetrojunction materials ,energy-band diagrams, current-voltage characteristics. Optical Devices :- Optical absorption, solar cell, Light Emitting device.

References:
4. MOS Field Effect Transistor and Integrated Circuits by Paul Richaman, John Wiley and Sons.

MIC 6102: INTEGRATED CIRCUIT TECHNOLOGY

Max. Marks: 50
Credit Theory : 4
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.
• Crystal growth and wafer preparation, defects, clean room concept, wafer cleaning techniques.
• Oxidation diffusion, Epitaxy, Ion Implantation, Metallization, Lithography, Etching.
• Typical Bipolar and MOS device fabrication techniques.
• Integration of unit processes, process modeling, IC Packaging, Reliability and failure analysis.

References:
5. Silicon VLSI Technology, James D. Plummer and Michael D. Deal Pearson Education. 2001

Practical:
1. Introduction to process simulation tools, e.g. SUPREM, MINIMOS, STEPS etc.
2. Simulation of typical MOS processes and MOSFET Characteristics, extraction of parameters for circuit simulation.

MIC 6103: MOS INTEGRATED CIRCUIT MODELLING

NO Max. Marks: 50

Credit Theory : 3

Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

• Characteristics of MOS digital circuits, Inverters, NMOS NOR and NAND gate logic circuits.
• CMOS Logic gates, transmission gates, signal propagation delays, Noise in Digital logic circuits.
• Random Logic vs. standard logic forms, PLA Structured gate layout.
• Clocking systems, clocked CMOS logic, semiconductor memories.
• Microprocessor design, Device modeling, Circuit modeling.

References:
2. Introduction to VLSI Systems, Mead and Convey, Addison Wesley. 1982

PRACTICALS
• Simulation using schematic editor
• Schematic page editor. Part editor, programmer’s editor,
• Session Log editing properties- spreadsheet editor property editor.
• Hierarchical design- Hierarchical blocks, ports, pins
• Placing, editing and connecting parts
• Editing and adding graphics
• Configuring a macro
• Creating a netlist
• Exporting and importing schematic data
• Analog stimuli-VSTIM, ISTIM
• Editing and creating models
• Digital simulation-Digital simuli DIGLOCK
• Simulation Parameters
• D.C Sweep Analysis
• Transient Analysis
• AC Sweep Analysis
• Parametric Analysis
• Performance Analysis
MIC 6104: COMPUTER AIDED DESIGN METHODOLOGIES AND TOOLS

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Introduction to VLSI design methodologies and supporting CAD tool environment. Overview of C and Data structures, Graphics and CIF, concepts and structure and algorithms for some of the CAD tools.
- Schematic editors, layout editors, Module generators, silicon compliers, placement and routing tools.
- Behavioral, functional, logic and circuit simulators, Aids for test vector generation and testing.

References:
1. Computer Aids for VLSI by Steven M. Rubin (Addison-Wesley) 1980
3. An introduction to VLSI Physical design, Majid Serafzadeh, McGraw Hill.2002

PRACTICAL
Study of
- schematic,
- layout editors,
- layout of gates, cells,
- layout optimization,
- use of silicon compliers.

MIC 6105: HARDWARE DESCRIPTION LANGUAGES AND VLSI DESIGN

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Design Environment, Design automation, role of EDA tools in design automation, introduction to different EDA tools, simulation and synthesis issues.
- Design entry through schematic, Design simulation with SPICE, Designing with VHDL features and capabilities of VHDL, levels of abstraction and basic building blocks, modes and language elements, behavior modeling, Data flow and structural modeling.
- VHDL description of combinational circuits, VHDL modeling of finite state machines, PLD based system design- features of different CALD devices, physical downloading of design on CPLD chip, FPGA chip.

References:

1. VHDL by Douglas Perry, Tata Mc Graw Hill 2004
2. VHDL Analysis & Modelling of Digital system by Navabi Z., Mc Graw Hill, 2002

MIC 6106: Material Science & Engineering

Credit Theory: 3
Max. Marks: 50

Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Material Science: Atomic Bonding, Crystal structure and Defects, Diffusion, Mechanical Behaviour, Thermal Behaviour, Failure Analysis & prevention.
- Materials of special applications viz. cryogenic, high temperature, high frequency applications.

References:


MIC 6107: EMBEDDED SYSTEM DESIGN

Max. Marks: 50

Credit Theory : 3

Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Introduction: A system, processors and other hardware units for embedded systems, embedded into system, regular processors and microcontrollers for embedded systems.

- Hardware Aspects: Brief discussion about processor structure, registers, memories, parallel and serial communication and ports, timers and interrupts.

- Programming Tools and handheld Devices: Using embedded C++, use of RTOS μc/os-I, use of RTOS Vx Works, Kernel of an embedded system and device drivers.

- Using Multiple Processors in Embedded Systems: Multiple process in parallel, modeling tools for a multiprocessor system, distributed embedded systems, Systems on chip(SOC).

- Design of an embedded system: System design, design cycle development phase for an embedded system, users of target systems, emulator and ICE, use of software tools for embedded systems, scopes and analyzers for system hardware tests.

References:
1. Embedded Systems, Raj Kamal, Tata Mcgraw Hill. 2004
2nd SEMESTER

MIC 6201: DIGITAL INTEGRATED CIRCUITS & SYSTEMS

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Noise Considerations in logic families.
- Digital system implementation using algorithmic state m/c concepts, Register transfer, bus clocking and control, asynchronous and synchronous systems.
- High speed adders, multipliers, FIFOs, and Barrel shifters, ALU control semiconductors for memories and PLAs, microprogrammed and PLA based control design.
- Data transfer techniques-examples of interface chips. Channel communication- protocols and standard.

References:

MIC 6202: MEASUREMENT AND CHARACTERIZATION TECHNIQUES

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Measurement of Resistively, Film thickness, reflectivity, refractive-index, stress, line width.
- Doping profile, Electron Beam Techniques (STM, AFM, TEM, SEM, electron beam induced current (EBIC) and voltage contrast technique).
- AES, Electron Microphone (EDX), LEED, RHEED, Ion beam Techniques (SIMS, RBS), X-ray techniques (XPS, X-ray Topography).
References:
1. Imperfections and Impurities in Semiconductor Silicon By K.V. Ravi, John Wiley and Sons.
2. Characterization of Semiconductor Materials by Philip F. Kare and Greydon B. Laubee, Mc-Graw Hill.

MIC 6203: ARCHITECTURE OF VLSI SYSTEMS

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Overview of architectural schemes, organization, representations and systems, single processor design, mechanism for higher performance.
- CISC Vs RISC, memory organization, cache Memory, I/O subsystems and control unit design, Algorithms.
- Specific architecture, upper computer architecture, pipeline and overlap processing, data flow, systolic, distributed and paralleled architectures.

References:
3. Computer system organization and Architecture, Carpinellie, Pearson Education. 2001

MIC 6204: ANALOG AND MIXED SIGNAL DEVICE DESIGN

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

PART- A
Theory and Design of Differential and general operational Amplifier with Bipolar Technology, Analog VLSI issues in CMOS technologies, Basic MOS Models, SPICE Models and frequency dependent parameters. Single stage amplifiers:-basic concepts, common-source stage, source follower,
common-gate stage. Passive and active current mirrors: basic current mirrors, cascode current mirrors, active current mirrors. MOS Differential amplifier. CMOS op-amps: Design of CMOS op-amp, compensation of op-amp, design of two state op-amp. [23]

PART-B

Textbooks :

PRACTICAL
- Simulation of analog integrated circuits
- Simulation & characterization of mixed signal devices

MIC 6205: ADVANCED MEMORY TECHNOLOGY AND DESIGN

Max. Marks: 50
Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Basic Memory Architecture and Cell Structure, Application- Specific DRAM Architectures and Design.
- Advanced Nonvolatile Memory Design and Technology, Embedded Memory Design and Applications.

References:

**MIC 6206: MEMS AND MICROSYSTEMS**

Max. Marks: 50

Credit Theory : 3

**Note for paper setter**: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Overview, Working principle of microsensors & microactuation, Scaling laws in geometry, electrostatic & electromagnetic forces, electricity, fluid mechanics and heat transfer.
- Materials for MEMS, active substrate materials, polymers as MEMS materials. Considerations for microfabrication, bulk micromanufacturing, surface micromachining, LIGA process.
- Microsystems packaging, die-, devices-and system-level packaging, interfaces in microsystem packaging for different applications, signal mapping and transduction.
- Microsystem design considerations, process design, mechanical design, mechanical design using FEM, design considerations for optical, fluidic, RF and Bio-MEMS.
- Overview of CAD tools for MEMS design and simulation.
References:

1. MEMS & Microsystem- Design & Manufacture, Tai-Ran Hsu, Tata McGraw Hill.2002

MIC 6207: RF and High Speed Digital Design

Max. Marks: 50

Credit Theory : 3
Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- High speed Design: ideal transmission line fundamentals, Crosstalk.
- Non Ideal interconnect issues, connectors packages and vias, Non ideal return paths, simultaneous switching noise, and power delivery, buffer modeling, digital timing analysis, timing specific design methodologies, radiated emissions compliance and system noise minimization, high speed measurement techniques.
- RF Design: Introduction to RF Electronics, basic concepts in RF design, MOS Review, Path Loss Small Signal Model, Receiver Design RF Transreceivers, Low Noise RF amplifiers and Mixers, RF Power amplifiers, RF Oscillators.

References:

   : Passive Circuits and Systems by Les Besser, Rowan Gilmore
3rd SEMESTER

MIC 7101:  LOW POWER DIGITAL CMOS DESIGN

Max. Marks: 50

Credit Theory    : 3

Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Hierarchy of limits of power.
- Sources of power consumption, power estimation, Synthesis for low power, Voltage scaling approaches.
- Design and test of low power circuits, Adiabatic switching, Minimizing switched capacitance.
- Low power static RAM architecture, Low energy computing using energy recovery techniques, low power Programmable computation, Software design for low power.

References:

1. Low power CMOS VLSI Circuit Design, Kaushik Roy and Sharat Parsad, John Wiley & Sons. 1998

MIC 7102: Microelectronics Packaging and Testing

Max. Marks: 50

Credit Theory    : 3

Note for paper setter: Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.
• **Packaging:** Introduction, Packaging Hierarchy, Package parameters, packaging substrates, package types, Hermetic packages, die attachment techniques, package parasitic, package modeling, packaging in wireless application, future trends.

• **Testing:** Introduction, basic concepts, DFT, importance of test, boundary scan test, boundary scan controller, faults, faults models, physical faults, stuck- at faults, logical faults, CAD for stuck-at faults and path delays, IDDQ tests, fault collapsing, fault/ Automatic test pattern generation, Basic, ATPG algorithm, PODEM algorithm, Built- in self test, LPSR, MISR.

References:


**MIC 7103: NANO SCALE DEVICES AND SYSTEMS**

**Max. Marks:** 50

**Credit Theory:** 3

**Note for paper setter:** Total of seven questions may be set covering the whole syllabus. Candidates will be required to attempt any five.

- Introduction, sub micron scaling, ballistic effects in MOS Devices, quantum transport phenomenon, nanoscale modeling.
• Overview of Quantum Dots, Resonant tunneling devices (Diodes and transistors), Single electron effects and Coulomb Blockade, Introduction to Nano electro mechanical systems (NEMS).

• Introduction to Molecular electronic devices, self assembled monolayers (SAM), Diodes, Optoelectronic Devices, Switches, Nanowires, programmable logic arrays, digital gates, flip-flops, shift registers, memories, rectifiers, Overview of nano materials.

• Nano Fabrication Techniques (Lithography, Self-Assemble, contact imprinting and Binding of organics and semiconductors).

References:


2. Nanotechnology: G. Timp, Bell Labs, Murray Hill, NJ (Ed.)


MAJOR PROJECT

Each student will be required to work on the major project approved by department faculty that will span III and IV semesters during which periodic progress reports will be monitored. At the end of III semester, project progress will be evaluated by the departmental faculty.

At the end of IV semester, the student will submit the thesis based on his project work.